ORNAMENTALS

FUNGICIDE BENEFITS ASSESSMENT

National Agricultural Pesticide Impact Assessment Program (NAPIAP)

FUNGICIDE BENEFITS ASSESSMENT

NURSERY CROPS

January, 1991

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This Report Represents a Portion of the USDA/States
National Agricultural Pesticide Impact Assessment Program (NAPIAP)
Fungicide Assessment Project

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PREFACE

Plant diseases affect all the major food crops world-wide and must be controlled to prevent significant production losses and maintain food quality for animals and humans. In addition, fungicides are a necessary factor in maintaining the availability of fiber and landscape improvements ranging from forest management to enhancements through the use of ornamentals. Agricultural fungicides are a significant component in effective disease control and are critical to plant health management systems. Fungicides provide benefits to producers as well as consumers and to local as well as national economies. Farmers benefit from the prevention of yield losses, improved crop quality, enhanced market opportunities, facilitation of farmwork and harvest. Consumers also benefit from an ample, varied, safe, healthy and inexpensive food supply that is available throughout the year.

This is one of 11 separate reports that assessed the beneficial aspects of fungicide use in U.S. agriculture. The 11 reports, all using a commodity approach in evaluating fungicide use, comprise the Fungicide Benefits Assessment. This assessment represents one part of the USDA/States National Agricultural Pesticide Impact Assessment Program's Fungicide Assessment Project. The two other parts deal with (a.) a treatise examining the health and environmental factors associated with the agricultural use of fungicides, and (b.) an assessment of the status as well as the management strategies for fungal resistance to fungicides in the U.S.

The 11 Fungicide Benefits Assessment reports were prepared by a team of scientists (team leaders). The team leaders and the listing of their reports (by commodity) in the Fungicide Benefits Assessment are as follows:

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NATIONAL FUNGICIDE BENEFITS ASSESSMENT PROJECT

ORNAMENTALS

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INTRODUCTION

The objectives of this study were to determine the amounts of specific nursery, greenhouse, landscape and forest species grown annually; percentages of crops affected by specific diseases; efficacy of fungicidal control according to specific labelled fungicides; and alternative control procedures in lieu of chemical control products as well as other pertinent information related to each host-parasite and control system.

The following is an "expert opinion" survey compiled by a team of professional plant pathologists from state and federal institutions that represent one of the most knowledgeable information bases in the "Green Industry". The following report is by no means inclusive but represents the most accurate assessment available at present. The complexity of the multifaceted, diverse "Green Industry" created special problems in accumulating the data in the following report. Some information was not available.

SUMMARY OF ASSESSMENT

I. CONIFEROUS TREE SPECIES

Arborvitae - Insignificant fungicide use (IFU)

Junipers (Juniperus spp.) - Approximately 8,000,000 plants are in nursery crop production. Phomopsis tip blight is the most serious disease in these operations. The fungicide most commonly used is Benlate 50WP, applied approximately 2-3 weeks with 6-8 sprays during the growing season. Bordeaux mixture, maneb and mancozeb are also labelled but not as effective. Phomopsis tip blight decreases or eliminates infected plants as marketable products resulting in substantial losses of up to 50% without preventive fungicide applications.

Pines - Fungicide use not usually a limiting cultural factor except in some of the needle cast diseases within propagation and seed beds.

Christmas tree species - Blights and needle cast diseases could affect 500,000 acres of Christmas trees out of 900,000 acres grown in the U.S. if Bravo were not available. Bordeaux mixture, benlate and maneb are alternatives but not as effective.

II. DECIDUOUS TREES (FOREST AND LANDSCAPE)

Ash, maple, oak, poplar, sycamore and walnut are affected at an estimated rate of 5-10% of leaf spot disease in forests and on the landscape, but fungicides are not used in general.

Crabapple - Apple scab (Venturia inaequalis) is the primary disease that is chemically controlled by fungicide on deciduous tree species. Captan has been the most effective control chemical.

III. GREENHOUSE

Bedding plants - 10,000 acres of various ornamental bedding plants are affected by Botrytis (gray mold), Pythium and Phytophthora root rots, Rhizoctonia, mildew and damping-off. Without Chipco 26019, Benlate, Captan, Terrachlor, Truban/Terrazole, Banrot and Subdue, 10-15% losses would occur in general.

Bulbs (Daffodil, Dahlia, Easter Lilies, Gladiolus, Hyacinth, Iris, Day lilies, Narcissus, Tulip) - At least 17,000 acres of bulbs are produced each year in the U.S. Up to 90% of various crops could be destroyed by root, stem, corm rots (i.e., Sclerotium, Rhizoctonia, Fusarium, rusts and leaf spots). Terrachlor, Benlate, Triadimefon, and Chlorothalonil are the major chemical control agents that allow bulb production to be profitable.

Carnation - At least 3,633,000 sq. ft. of commercial greenhouse area are devoted to carnation production primarily in Colorado and California. Root rots, gray mold, rusts and other fungal diseases would decrease flower quality and curtail production if chemical control was not available. Products such as banrot, benomyl, daconil, truban, terrachlor, ridomil and iprodione reduce potential losses of 90-100% to insignificant levels.

Gardenia - 100% of the 15 acres of gardenia are diseased (Phomopsis) and would be lost without Benomyl.

Poinsettia - Root rots caused by Pythium, Rhizoctonia, and Thielaviopsis, Botrytis blight and damping-off affect up to 30,000 acres of Poinsettia. Control is achieved with Banrot, Benlate, Chipco 26019, Chlorothalonil, Ornalin, Subdue and Truban. Mancozeb is an alternative for Botrytis blight control. Only soil fumigation and soilless potting media are alternative management practices.

Rose - Information was not available.

IV. SHRUBS (WARM TEMPERATE AND SUBTROPICAL CLIMATE)

Aucuba - 10% nursery and 10% landscape plants are diseased with mancozeb being the only control for Phyllosticta and Colletotrichum leaf spots.

Camellia - 5 to 15% of Camellia grown in nursery and landscape are affected by Glomerella dieback and only controlled by Benlate. Phytophthora root rot can destroy 100 acres (100%) Camellia in the nursery. Only metalaxyl controls it.

Crepe Myrtle - 5 acres of crepe myrtle are treated for powdery mildew with Rubigan, Zyban, Benlate, and Bayleton.

Wisteria - Acreage affected by Cercospora and Colletotrichum leaf spot and controlled by Benlate is not known.

Photinia - Almost 6 million Photinia plants are grown primarily in Georgia, Alabama, Florida, and California each year. Fungal leaf spot diseases, rust, powdery mildew, Botrytis canker, and root rots are controlled, respectively, by Triadimefon, Triforine, Mancozeb, Fenarimol and other products. Without the latter products commercial Photinia production would be impossible due to reduced plant quality and lack of propagation material.

V. SHRUBS (COOL TEMPERATURE)

Azalea, Rhododendron and Mountain Laurel (Kalmia) - Azalea, Rhododendron and Kalmia spp. are severely affected by root diseases throughout the United States in propagation bed and in the landscape. Seven to 8,000

acres of the above mentioned plants are annually grown in nurseries and gardens. Damping-off (Pythium), Phytophthora stem and root rots can be controlled by Banrot, Truban, Subdue, Banol, Ethazole, Aliette, Terrachlor and other products. Without them, production of these popular species is impossible. Petal blights, leaf spots, powdery mildew and leaf blights are controlled by Mancozeb, Chipco 26019, Ornalin and Bayleton, respectively. The latter allow production of high quality plants along with the use of sanitation and sound horticultural practices.

Boxwood (Buxus spp.) - Boxwood (Buxus spp.) is severely affected (8 to 10%) by Botrytis canker, macrophoma dieback and Volutella blight. Significant control is achieved using mancozeb. Left unchecked after infection or without proper horticultural practices, the above diseases significantly limit the cultivation of boxwood.

Data on euonymus, holly, Ligustrum and rose not available.

Pyracantha scab control data was not available.

CONCLUSION

Due to the diversity of nursery, greenhouse, landscape and forest crop species, the editor did not attempt to include all species and host-parasite/fungicide control systems that are labelled by the United States Environmental Protection Agency. While much of the data in the above report indicate injury or disease at 5 or 10%, apparently tolerable levels for other species such as field crops, such losses to high cash annual and perennial nursery, greenhouse, landscape and forest crops represent substantial reductions in grower income. Many of these losses represent reduced esthetic quality, not necessarily mortality.

Until effective alternative fungicides such as biorational products are available to control plant disease and loss, continued use of conventional fungicides listed in this report should be supported.

Recent concerns about worker safety, public hazard and environmental quality due to fungicide exposure should be continually addressed, if based on sound scientific experimentation. The benefits of fungicide use, if performed safely and legally, far exceed any risks to the general public who purchase, utilize and enjoy nursery, greenhouse, landscape and forest crops.

Table 1a. CONIFEROUS TREE SPECIES

Crop/Site	Acres in Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Arborvitae	5.5 million	Canker Dieback (Diplodia spp.)	1-15%	Ferbam WDG	As needed	early summer 10-14 days
Arborvitae	5.5 million	Lophodermium Needle Cast (Lophodermium spp.)	1-15%	Ferbam WDG	As needed	same as above
Arborvitae	5.5 million	Gray Mold (Botrytis cinerea)	1-15%	Ziram 76WDG	4-8	7-10
Arborvitae	5.5 million	Gray Mold (Botrytis cinerea)	1-15%	Ferbam WDG	through growing season	7-10
Arborvitae	5.5 million	Canker Dieback (Diplodia spp.)	<15%	Maneb	As needed	weekly
Christmas Trees (Idaho)	3,100 acres 185,000 trees per year	Lophodermium needle cast	5-10	Bravo	1-3	spring
Christmas Trees	5,000 acres	Lophodermium needle cast	40-50	Bravo	3 + 3	spring & fall; during 3rd & 4th year
Christmas Trees (Montana)	5-7,000 acres in plantations & wild trees; 1.5 million trees/ year from plantations and 3 million +	Lophodermium needle cast	40-60	Bravo	2-3	spring, early summer
Christmas Trees Eastern U.S.	5000 A	Swiss needle cast Rhabdocline needle cast Virula needle cast	5-15%	Bravo	1-2	Spring
Christmas Trees Eastern U.S.	5000 A	Western gall rust	10-25%	Bayleton	1-2/yr when trees are young	Spring
Christmas Trees Eastern U.S.	5000 A	Phytophthora root rot	10-20%	Subdue	2	Spring and fall on transplants
Juniperus/nursery	8,000,000	Phomopsis tip blight	45%	Benlate 50WP	6-8	2-3 wks

Table 1b. CONIFEROUS TREE SPECIES

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Arborvitae	Sprayer	---	50-100% of infected plants	sanitation, clean stock	other carbamates, rogue out diseased plants. Use clean planting stock
Arborvitae	Sprayer	---	50-75% of infected plants	same as above	other carbamates, Bordeaux mixture
Arborvitae	Sprayer	---	50-75% of infected plants	sanitation, increase spacing between pots, better ventilation	other carbamates, sanitation increase air movement between plants
Arborvitae	Sprayer	---	50-75% of infected plants	sanitation, increased spacing	other carbamates, better ventilation
Arborvitae	Sprayer	---	---	sanitation, use disease-free stock	other carbamates, eliminate diseased plants, use clean plant stock
Christmas Trees (Idaho)	ground sprayer	5-10%	premature loss of older needles	---	mancozeb
Christmas Trees (Texas)	ground (sprayer?)	40%	trees are not marketable if disease is not controlled	---	mancozeb materials are the only alternatives
Christmas Trees (Montana)	---	30%	premature loss of older needles reduces marketability; 100% of trees may not be marketable	---	mancozeb
Christmas Trees	1-2 lb/A ground sprayer	<1%	----		Mancozeb
Christmas Trees	0.25-0.5 oz/A	<1%	----		None
Christmas Trees	1.25 lb/A ground sprayer	<1%	100%	----	Aliette
Juniperus/nursery	Low pressure sprayer	8,000,000	50%		Sanitation/Bordeaux mixture mancozeb not as effective as Benlate

Table 2a. DECIDUOUS TREE SPECIES

Crop/Site	Acres In Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Ash	Approx. 10 million	Anthracnose	30	Benlate 50W and DF or Tersan 1991 DF	3-4	Spring, 7-14 day intervals
Ash	Approx. 10 million	Leaf Spots: Cercospora Cercosporidium Cylindrosporidium	trace	Daconil 2787, 40F, 75WP or 90 WDG	3-4	Spring, 7-14 day intervals
Ash	Approx. 10 million	Anthracnose, Leaf Spots	---	Dithane 75 DF, 37F-45, M-45 80% WP or Fore 80WP	3-4	Spring
Ash	Approx. 10 million	Anthracnose	30	Topsin-M 70% WP, 4.5 F	3-4	Weekly in early spring
Ash	Approx. 10 million	Anthracnose	30	Duosan (15% t.-m.*) (60% mancozeb)	3-4	Weekly in early
Ash	Approx. 10 million	Powdery mildew	<1%	Bayleton 25WP	1-5	In nursery, at bud break - autumn
Black Walnut	4 million	Cylindricladium Root Rot	30-40%	Terrazole 35 WP	As needed	4-12 week intervals
Black Walnut	4 million	Anthracnose-Gnomonia	90-95%	Ziram 76 WDG	1-2	fall & to dormant plants
Black Walnut	4 million	Anthracnose-Gnomonia	90-95%	Cyprex 65W (dodine)	---	at bud break & 10-14 day intervals
Maple	12 million	Tar Spot (Rhytisma acerinum)	5%	Bordeaux Mixture	2	at leaf expansion & 2-3 wk later
Maple	12 million	Tar Spot (Rhytisma acerinum)	5%	Copper oxychloride sulfate	As needed	at leaf expansion & 10-12 d

* t.m is an abbreviation for thiophanate-methyl

Table 2a. DECIDUOUS TREE SPECIES (continued)

Crop/Site	Acres In Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Oak	Approx. 17 million	Anthracnose Powdery Mildew	40-60% (<1% serious) (<5% anthr.)	Benlate 50W, DF & Tersan 1991 DF	3-4	Spring, 10-14
Oak	Approx. 17 million	Oak rot fungus Armillaria	<1%	Carbon disulfide, 100% liquid	1	Fall
Oak	Approx. 17	a. Anthracnose b. Leaf Blister c. Actinopelte leaf spot	50%	Daconil 2787, 40F, 90 WDG	2-4	7-14 a. spring b. dormant c. late summer
Oak	Approx. 17 million	a. Anthracnose b. Actinopelte leaf spot c. Dermatophora root rot	a. 75% b. ~20% c. ?	Bordeaux mixture 4:4:100; 5:5:50	1-2	Late dormant/bud break: spray;
Oak	Approx. 17 million	Anthracnose	<5%	COCS 5-56% WP	3-4	soil app, Spring 7-10
Oak	Approx. 17 million	Powdery Mildew	40-60% 1% serious	Fungicide 658 89 WP	4	Spring 7-10
Oak	Approx. 17 million	a. Leaf Blister b. Actinopelte leaf spot	45%	Dithane 75 DF, 37 F-45 M-45 80 WP. Fore 80 WP	1-3	a. when dormant b. in summer
Oak	Approx. 17 million	Oak wilt	<1%	Vapam 28.8 or 32.7% liquid	1	when soil is warm
Oak	Approx. 17 million	a. Anthracnose b. Powdery Mildew	a. <50% b. 50%	Topsin-M 70 WP, 4.5 F	3-4	a. spring b. summer
Oak	Approx. 17 million	Powdery Mildew	<1% warrant control; 40-60% become infected	Bayleton 25WP	4-6	bud break to late fall
Oak	Approx. 17 million	Leaf Blister	20	Basic Copper Sulfate 12.75-53% Copper	1-2	when dormant
Oak	Approx. 17 million	Anthracnose	<5%	Zineb 75WP		spring

Table 2a. DECIDUOUS TREE SPECIES (continued)

Crop/Site	Acres In Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Sycamore	Approx 6 million	a. Anthracnose b. Leaf spots c. Powdery Mildew	60-75% (<1%, 5% serious)	Benlate 50W, DF and Tersan 1991 DF	3-4	spring
Sycamore	Approx. 6 million	Anthracnose	30	Bordeaux mixture 4:4: 100	1-2	at bud swell and repeat
Sycamore	Approx. 6 million	Anthracnose	30	Citcop	3	at bud swell and 2x at 7d intervals
Sycamore	Approx. 6 million	Anthracnose	30	dodine (Cyprex 60 WP)	3	at bud swell, bud break & 10-14 days later
Sycamore	Approx. 6 million	Anthracnose	30	thiabendazole (Arbotect 20S)	1	annually, late summer
Sycamore	Approx. 6 million	Anthracnose	30	Duosan (15% t.-m.; 60% mancozeb)	3-4	spring, weekly

Table 2b. DECIDUOUS TREE SPECIES

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternative to Chemical Control/Problems
Ash	Hydraulic, Mist Blower 50:50	trace	None, some aesthetic loss	Improved spacing, rake up and and destroy infected leaves	mancozeb, t.-m, combination of these
Ash	Hydraulic, Mist Blower 50:50	0-trace	Not normally a serious problem	Same as above	mancozeb
Ash	Hydraulic, Mist Blower 50:50	trace-<1%	Not a serious enough problem to warrant control	Same as above	Anthrac.: benomyl, t.-m, t.-m+ mancozeb Leaf Spots: chlorothalonil
Ash	Hydraulic Mist Blower 50:50	trace	None, some aesthetic loss	Same as above	benomyl, t.-m, t.-m + mancozeb
Ash	Hydraulic Mist Blower 50:50	only a trace	None, some aesthetic loss	Same as above	t.-m, mancozeb, benomyl
Ash	Hydraulic Mist Blower 50:50	~10	Little or no loss	Improved spacing, tolerant cultivars	benomyl
Black Walnut	Soil Drench	0-800,000	30-40%	Sanitation, good drainage	---
Black Walnut	Spray	---	5-10%	Sanitation, disease-free stock	Other carbamates, sanitation disease-free stock
Black Walnut	Spray	---	5-10%	Sanitation, disease-free stock	carbamates, use sanitation, and disease-free stock
Maple	Foliar spray	---	sporadic, unsightly but not fatal	sanitation, rake & burn or bury infected leaves in fall	copper oxychloride sulfate
Maple	Foliar spray	---	sporadic, may weaken tree, not fatal	same as above	Bordeaux mixture

* t.-m. is an abbreviation for thiophanate-methyl

Table 2b. DECIDUOUS TREE SPECIES (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Oak	Hydraulic Mist Blower 50:50	trace	50% reduction in some cases. Mostly no loss.	Improved spacing	a. t.-m.*, zineb, fixed copper b. triadimefon, t.-m.
Oak	Hydraulic Mist Blower 50:50	<1 acre	Usually fatal to replant same species in infested soil.	Avoid replanting a susceptible host.	None
Oak	Hydraulic Mist Blower 50:50	0-trace	Not severe, no loss	Rake and destroy infected leaves	a. benomyl, t.-m, zineb, fixed copper b. mancozeb, tribasic $CuSO_4$ c. mancozeb, copper bordeaux
Oak	Hydraulic Mist Blower 50:50	0-trace	rarely serious enough to warrant control	Same as above plus eliminate plant stress to combat root rot	a. benomyl, zineb, t.-m., COCS b. mancozeb
Oak	Hydraulic Mist Blower 50:50	0-trace	Not severe	Rake and destroy fallen leaves	benomyl, zineb, t.-m.
Oak	NA	0	None, occasionally 50% reduction in seedlings	Increased spacing	benomyl, triadimefon, t.-m.
Oak	Hydraulic Mist Blower 50:50	<1%	Little or none	Rake and destroy infected leaves	a. chlorothalonil, tribasic $CuSO_4$ b. chlorothalonil, copper bordeaux
Oak	Soil injection	trace	Disease usually fatal to red oak group	Mechanical trenching	None cleared
Oak	Hydraulic Mist Blower 50:50	~10	Little to none; occasionally 50% reduction in yield	Improved spacing	a. benomyl, zineb, fixed copper b. benomyl, triadimefon
Oak	Hydraulic Mist Blower 50:50	~20	Little to none; occasionally 50% reduction in seedlings	Increased spacing	benomyl, t.-m.
Oak	Hydraulic Mist Blower 50:50	0-trace	None	None	mancozeb, chlorothalonil
Oak	Hydraulic Mist Blower 50:50	0-trace	Not severe	Rake and destroy infected leaves	benomyl, t.-m. fixed copper

t.-m. is an abbreviation for thiophanate-methyl.

Table 2b. DECIDUOUS TREE SPECIES (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Sycamore	Hydraulic Mist Blower 50:50	trace	a. <5% c. <1% serious	Improved spacing, rake & destroy infected leaves	a. thiabendazole, zineb, *t.-m. + mancozeb c. sulfur, triadimefon
Sycamore	Hydraulic Mist Blower 50:50	0-trace	<5%	Rake & destroy infected leaves	thiabendazole, zineb, benomyl, dodine copper hydroxide, copper-bordeaux, t.-m. + mancozeb
Sycamore	Hydraulic Mist Blower 50:50	0-trace	5% serious, only when other stresses are present	same as above plus, prune out infected twigs	thiabendazole, zineb, benomyl, dodine copper hydroxide, copper-bordeaux, t.-m. + mancozeb
Sycamore	Hydraulic Mist Blower 50:50	0-trace	5% trees, reduced vigor enough that other stresses could cause loss	same as directly above	same as above plus copper salts of rosin and fatty acids
Sycamore	Trunk Injection	trace	same as above	same as above	thiabendazole, zineb, benomyl, dodine, copper hydroxide, copper-bordeaux, t.-m. + mancozeb
Sycamore	Hydraulic	>0.1%	same as above	same as above	same as above

*t.-m. is an abbreviation for thiophanate-methyl

Table 3a. GREENHOUSE CROPS

Crop/Site	Acres In Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Bedding Plants	1334	Rhizoctonia Root Rot	not known	Chipco 26019	from seeding to shipping	14
Bedding Plants	1334	Rhizoctonia, Black and Fusarium root rots	not known	Benlate 50DF	2	from seeding to shipping preplant
Bedding Plants	1334	Pythium, Phytophthora & Rhizoctonia	not known	Captan 50W	1	preplant
Bedding Plants	1334 ~26 million flats	Rhizoctonia root rot	not known	Terrachlor 75W	1	10-14
Bedding plants	1334	Pythium root & crown rot, Phytophthora root rot	10%	Truban/Terrazole 35W or 35W	from establish-ment to shipping	from seeding to market
Bedding plants	1334	Pythium & Phytophthora root rot	10%	Banol 66.5S	1	30
Bedding plants	1334	Rhizoctonia, Fusarium, Thielaviopsis root rot Pythium and Phytophthora	10%	Banrot 40W	2	from seeding to market
Bedding plants	1334	Pythium and Phytophthora root rot	10%	Subdue 2E	1	

Table 3a. GREENHOUSE CROPS (continued)

Crop/Site	Plants or Area in Cultivation	Disease/Organism	% Area Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Carnation	3,633,000 sq ft under	Rhizoctonia root rot *Fusarium roseum* glass	10%	Banrot 40WP	-	As needed
Carnation	3,633,000 sq ft under glass	Fusarium	50%	Benomyl	1-3	After cutting
Carnation	Same as above	Fairy Ring	50%	Daconil 2787 75%WP	weekly all spring; all fall	7-10 days
Carnation	3,633,000 sq ft under glass	Botrytis, Rhizoctonia	50%	Iprodione	Intermittent	Every 5-10 days
Carnation	Same as above	Pythium, Phytophthora	10-20%	Metalaxyl (ridomil)	1-2	As needed
Carnation	Same as above	Botrytis	50%	Ornalin	Intermittent	5-7 days
Carnation	Same as above	Rust	10%	Oxycarboxin	1-5	At first sign of rust
Carnation	Same as above	Rhizoctonia	50%	Quintozene	2	Preplant
Carnation	Same as above	Pythium	50%	Truban 25EC	1-2	Every 6 months after planting
Carnation	Same as above	Rhizoctonia	40%	Terrachlor (PCNB)	1	1X/yr

Table 3a. GREENHOUSE CROPS (continued)

Crop/Site	Plants in Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Poinsettia	26,909,000	a. Pythium b. Rhizoctonia c. Thielaviopsis	5-10%	a.,b.,c.: Banrot WP or G	3-4	all: at planting and monthly
Poinsettia	26,909,000	a. Rhizoctonia root rot b. Thielaviopsis c. Botrytis Blight	a. & b.: 2-3% c. 5-10%	Benlate WP or DF for all	3-4 soil drench	drench at planting: spray 14 d in early season
Poinsettia	26,909,000	Botrytis Blight	5-10%	Chipco 26019	8	7-14
Poinsettia	26,909,000	Botrytis Blight	5-10%	Chlorothalonil	8-12	7-14
Poinsettia	26,909,000	Botrytis Blight	5-10%	Cleary's 3336 (t.-e.)	8	7-14
Poinsettia	26,909,000	Botrytis Blight	5-10%	Ornalin (Vinclozolin)	8	7-14
Poinsettia	26,909,000	Pythium root rot	5-10%	Subdue EC/G (metalaxyl)	3-4	at planting than monthly
Poinsettia	26,909,000	Pythium root rot	---	Truban WP, EC, or G (etridiazole)	3-4	same as above

t.-e. is an abbreviation for thiophanate-ethyl

Table 3b. GREENHOUSE CROPS

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problem
Bedding Plants	drench	200 A; 3.9 million flats	2.5%	preventive, sanitation, soilless mixes new containers, raised benches, clean water, good growing.	Benlate, Banol formulations Terraclor 75W
Bedding Plants	drench & spray	500 A; 9.7 million flats	5-10%	same as above	Chipco 26019, Banrot 8G & 40W Terrachlor 75W
Bedding Plants	dip & hydraulic sprayer	50 A; 977,736 flats	2-15%	same as above	Subdue 2E, 2G, Truban/Terrazole 30W & 5G, Banrot 8G & 40W
Bedding Plants	soil drench	75 A; 1.4 million flats	2-5%	same as above	Chipco 26019, Benlate, Banrot 8G & 40W
Bedding Plants	soil drench & soil incorporation	300 A; 5.8 million flats	5-10%	same as above	Subdue 2E & 2G, Banol 67S
Bedding Plants	soil drench with hydraulic equipment	25 A; 488,868 flats	5-10%	same as above	Subdue 2E & 2G, Truban/Terrazole 30W, 35W & 5G
Bedding Plants	hydraulic sprayer as soil drench	600 A; 11.7 million flats	12-15%	same as above	Chipco 26019, Benlate, Terraclor
Bedding Plants	soil drench	400 A; 7.8 million flats	5-10%	same as above	Banol 66.5S, Truban/Terrazole

Table 3b. GREENHOUSE CROPS (continued)

Crop/Site	Application	Area Treated	Yield Loss W/O Fungicides	Control Management Practices	Alternative Chemical Control/Problems
Carnation	Preplant 36 oz/100 sq ft	2,000,000	10%	Soil sterilization	Terrachlor; truban + Benlate
Carnation	Aerosol coverage 0.5 lb/100 gal/A	25%	10-20%	NA	None
Carnation	Sprayer 1.5 #1/100 gal water	1,000,000	100%	Spraying, reduce humidity	NA
Carnation	Spray; 100 gal at planting	1,000,000	100%	Humidity and temp control	Ornalin, daconil
Carnation	Irrigation 1-2 fl oz/100 gal/ 400 sq ft	95%	10-20%	NA	NA
Carnation	Spray 1 15#/100 gal	1,000,000	100%	Humidity and temp control	Chipco
Carnation	Aerosol spray .75 lb/100 gal/A	10%	10-20%	Control humidity	NA
Carnation	Granules applied to soil 1 lb/1000 sq ft	50% 10-50%	NA		NA
Carnation	18 oz/100 sq ft	100%	100%	None	Iprodione, Metalaxyl
Carnation	Drench 2.5# Terrachlor drench 300 gal water/1000 sq ft bench	600,000 sq ft	100%	NA	Banrot

Table 3b. GREENHOUSE CROPS

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Poinsettia	WP: soil drench; G: soil incorp.	18.54 million	5-10%	soil fumigation, soilless potting mix	sanitation, etridiazole, metalaxyl + benomyl, t.-m.
Poinsettia	drench or incorp.	24.326 million	5-10%	soil fumigation, soilless potting mix	sanitation, iprodione, vinclozolin, mancozeb, chlorothalonil for 50-75% control at best
Poinsettia	foliar spray	7.965 million	5-10%	low humidity	mancozeb, chlorothalonil for 50-60% control
Poinsettia	thermal smoke	12.351 million	5-10%	low humidity	mancozeb for 50-60% control at best
Poinsettia	foliar spray	1.884 million	5-10%	low humidity	mancozeb, chlorothalonil for 50-75% control
Poinsettia	foliar spray	3.391 million	5-10%	low humidity	mancozeb & chlorothalonil
Poinsettia	EC: drench G: soil incorp.	18.944 million	5-10%	soil can be chemically fumigated, can use soilless potting mixes	etridiazole or etridiazole + t.-m. (there is metalaxyl resistance)
Poinsettia	WP,EC: soil drench, G: soil incorp.	10.172 million	---	chemically fumigated soil, or soilless potting mixes	etridiazole + thiophanate-methyl

t.-m. is an abbreviation for thiophanate-methyl

Table 4a. BULBS

Crop/Site	Plants or Area in Cultivation	Disease/Organism	% Area Infected	Chemical Formulation	Number of Applications	Timing (days)
Daffodil/Narcissus	1500-2000 A	Crown Rot, Sclerotium rolfsii	10-20%	Terrachlor 75W		
Daffodil/Narcissus	1500-2000 A	Leaf Scorch, Stagonospora	60-80%	Daconil 2787, Bravo	3-6	2-4 wk intervals during spring
Daffodil/Narcissus	1500-2000 A	Fire - Botrytis polyblastis	60%	Benlate 50W	2	April-May
Daffodil/Narcissus	1500-2000 A	bulb and stem nematode	40-60% of bulbs	Formaldehyde	1	harvest
Daffodil/Narcissus	1500-2000 A	Fusarium basal rot	80-100%	Benlate 50W	1	harvest or preplant
Dahlia	400-500	Powdery mildew	50-70%	Benlate	2-5	Summer
Gladiolus	7000 A	Fusarium yellows and corm rots, Curvularia leaf spot	70-80%	Benlate 50W	1 or 2	Harvest and preplant
Gladiolus	7000 A	Stromatinia neck rot and corm rot	70-90%	Tersan 75	1	Harvest
Gladiolus	7000 A	Botrytis leaf & flower spot, Curvularia leaf spot Stemphyllium leaf spot	100%	Daconil 2787	20-45	Every 3-14 days

Table 4a. BULBS (continued)

Crop/Site	Plants or Area in Cultivation	Disease/Organism	% Area Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Hyacinths	20,320,000 bulbs	Blue mold, Penicillium		Benlate	1	at harvest
Bulbous Iris	1500-2000 A	Leaf rust	10%	Bayleton	3-4	3-4 wk
Rhizomatous Iris	1000 A	Heterosporium leaf spot	80-100%	Benlate 50W	6-10	1-2 wk intervals during spring
Rhizomatous Iris	1000 A	Crown rot, Sclerotium rolfsii	80-100%	Terrachlor 75W	1	preplant
Lily (Easter, Asiatic, Oriental)	2500 A (1500 Easter)	Fire, Botrytis elliptica		Bordeaux mixture	5-15	Every 1-3 wk during growing season
Lily (Easter, Asiatic, Oriental)	2500 A (1500 Easter)	Root rot complex, crown rot caused by Sclerotium rolfsii	100%	Terrachlor 75W infurrow	1	Preplant or
Lily (Easter, Asiatic, Oriental)	2500 A (1500 Easter)	Fusarium basal rot	70-90%	Benlate 50W	1	Harvest
Lily (Easter, Asiatic, Oriental)	2500 A (1500 Easter)	Pythium	90-100%	Truban	1-3	Preplant and during forcing
Tulip	1000-1500 A	Crown rot, Sclerotium rolfsii, Rhizoctonia Sclerotinia	80-100%	Terrachlor 75W	1	preplant
Tulip	1000-1500 A	Fusarium basal rot Penicillium blue mold	90-100%	Benlate 50W	1 or 2	harvest/preplant
Tulip	1000-1500 A	Botrytis (fire)	100%	Chipco 26019 50W	6-10	1-2 wk
Tulip	1000-1500 A	Pythium	90-100%	Truban	1-3	Preplant and during forcing

Table 4b. BULBS

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Daffodil/Narcissus	2.3 lb/5 gal - dip 3.4-4.5 lb/1000' of row - infurrow 106-212 lb/A broadcast	10-20%	75-100%	None	
Daffodil/Narcissus	1 lb/A ground	20%	30-40%	Benlate 50W, Chipco 26019	
Daffodil/Narcissus	0.5 lb/A ground	40%	20-30%	Vorlan, Ornalan, Daconil 2787 Bravo	
Daffodil/Narcissus	0.4 pt/25 gal dip - hot water	100%			
Daffodil/Narcissus	1 lb/100 gal dip	50-80%	10-100% depending on susceptibility	Mertect	
Dahlia	0.5 lb/acre ground tubers - 10-20%	50-70%	flowers-100%	Bayleton	
Gladiolus	0.5-1.0 lb/100 gal dip	90-100%	40-50%	No alternative for benomyl with Fusarium; captan or Daconil are commonly used as a mixture with benomyl to control other problems such as Curvularia leaf spot	
Gladiolus	0.75 lb/8 gal - dip	40%	25%	Botran	
Gladiolus	1 lb/100 gal ground sprays	90-100%	70% Botrytis; 40% Curvularia; 30-35% Stemphyllium	Maneb, Zineb, Mancozeb, Iprodione, Benomyl, Vinclozolin, Dyrene	

Table 4b. BULBS (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Hyacinths	1 lb/100 gal dip	25% of bulbs	Unknown	Mertect	
Bulbous Iris	0.25-0.5 oz/A ground	10%	100%	-----	Maneb, Mancozeb
Rhizomatous Iris	0.5 lb/A blower	80-100%	20-40%	Kocide 101, Bayleton, Zineb, Bravo	
Rhizomatous Iris	1.5-3 lb/100 gal dip	100%	50-100%	Used in combination with benomyl	
Lily (Easter, Asiatic, Oriental)	8-8-12	200%	50%	Benomyl, Chlorothalonil, Maneb Mancozeb, Iprodione, Vinclozolin, Zineb (most of these alternatives are used on the Asiatic & Oriental lilies)	
Lily (Easter, Asiatic, Oriental)	3-4 lb/100 gal, dip 3.4-4.5 lb/1000' of row for infurrow	90-100%	100%	None	
Lily (Easter, Asiatic, Oriental)	0.5-1 lb/100 gal bulb dip	90-100%	100%	Mertect	
Lily (Easter Asiatic, Oriental)	1-3 oz/400 ft^2 drench 2.7 oz/100 gal, dip	90-100%	70-100%	----	Metalaxyl
Tulip	2.3 lb/5 gal, dip; 3.4-4.5 lb/100 ft of row, infurrow	80-100%	100%		
Tulip	0.8 lb/100 gal, dip	80-100%	100%	Mertect, Topsin M	
Tulip	0.5-1.0 lb 10% aerial, 90% ground	100%	30-50%	Vinclozolin, Mancozeb, Benomyl Chlorothalonil, Ferbam	
Tulip	1-3 oz/400 ft^2, drench 2.7 oz/100 gal dip	90-100%	70-100%	Metalaxyl	

Table 5a. SHRUBS, WARM TEMPERATE

Crop/Site	Acres In Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Aucuba/ Landscape	100	Leaf Spots/ Phyllosticta spp. Colletotrichum spp.	10	Mancozeb/M-45 (80W)	5	7-10
Aucuba/ Nursery	20	Leaf Spots/ Phyllosticta spp. Colletotrichum spp.	10	Mancozeb/M-45 (80W)	5	7-10
Camellia/ Nursery	1000	Dieback Glomerella spp.	5	Benomyl/50W or 50DF	3-5	10-14
Camellia/ Nursery	1000+	Dieback/ Glomerella spp.	5	Benomyl/50W or 50DF	3-5	10-14
Camellia/ Nursery	1000+	Root Rot/ Phytophthora cinnamomi	15	Metalaxyl/(25.1%) Subdue 2E 0.5 fl. oz./100 gal @ 1 pint/sq.ft.	2-4/year	monthly
Camellia/ Nursery	100	Root Rot/P. cinnamomi	100	See immediately above	2-4/year	monthly
Gardenia/ Landscape	20	Canker Phomopsis spp.	75	Benomyl/50W or 50DF	3-5	10-14
Gardenia/ Greenhouse & Nursery	15	Canker Phomopsis spp.	100	Benomyl/50W or 50DF	3-5	10-14

Table 5a. SHRUBS, WARM TEMPERATE (continued)

Crop/Site	Acres In Cultivation	Disease/ Organism	% Acres Infected	Chemical Formulation	Number of Applications	Timing (Days)
Crepe Myrtle	260 Acres; 6 million plants annually	Powdery Mildew	5%	Zyban/Duosan 75W	3	14
Crepe Myrtle	260 Acres; 6 million plants annually	Powdery Mildew	5%	Rubigan AS	3	14
Crepe Myrtle	260 Acres; 6 million plants annually	Powdery Mildew and Cercospora Leaf Spot	5%	Benlate 50DF	3	14
Crepe Myrtle	260 Acres; 6 million plants annually	Powdery Mildew	5%	Bayleton 25WP	3	14
Crepe Myrtle	260 Acres; 6 million plants annually	Powdery Mildew	5%	Triforine 1.6 EC	3	10-14
Wisteria	1 Acre (est.)	Cercospora and Colletotrichum leaf spots	not known	Benlate 50DF	4	14

Table 5a. SHRUBS, WARM TEMPERATE (continued)

Crop/Site	Plants or Area in Cultivation	Disease/Organism	% Area Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Photinia spp. & cultivars	5.7 million plants	Entomosporium leaf spot Anthracnose, powdery mildew	100%	Chlorothalonil	24-36/yr	Weekly to bi-weekly
Photinia spp. & cultivars	5.7 million plants	Entomosporium leaf spot, rusts, powdery mildew	100%	Triadimefon	5	Apply at budbreak at 2 to 3 wk intervals
Photinia spp. & cultivars	5.7 million plants	Powdery mildew	12-13%	Triforine	24-36	Weekly during high disease
Photinia spp.	5.7 million plants	Anthracnose	100%	Mancozeb	10-12	Weekly to bi-weekly
Photinia spp. & cultivars	5.7 million plants	Powdery mildew	10-15%	Fenarimol		Weekly to bi-weekly
Photinia spp. & cultivars	5.7 million plants	Botrytis canker	25-35%	Benomyl	3	Initiate sprays at bud break

Table 5b. SHRUBS, WARM TEMPERATE

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Aucuba/ Landscape	Foliar Spray 5-10	5-50%	Avoid overhead irrigation in summer	None	
Aucuba/ Nursery	Foliar Spray 5-10	5-50%	Avoid overhead watering, spacing spacing plants, use of disease-free stock.	Use of disease free propagation stock.	
Camellia/ Landscape	Foliar Spray 5-50	5-25%	Avoid overhead irrigation	None	
Camellia/ Nursery	Foliar Spray 5-50	5-25%	Increase plant spacing/avoid overhead irrigation	Use clean stock plants, grow only in areas where disease is not present.	
Camellia/ Landscape	Drench 100	50-100%	Plant in well-drained areas, sanitation.	None	
Camellia/	Irrigation 100	50-100%	Use of clean stock, uninfected soil, gravel drainage, clean water	Infected plants though Nursery symptomless would grow poorly after transplanted. P. cinnamomi then be spread around landscape.	
Gardenia/ Landscape	Foliar and Stem Spray	5%	Use of clean stock	None	
Gardenia/ Greenhouse Nursery	Foliar and & Stem Spray	5%	Strict sanitation, clean plants, soil sterilization	Sanitation and clean propagation stock.	

Table 5b. SHRUBS, WARM TEMPERATE (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Crepe Myrtle	foliar application	2 acres; 46,200 plants	none, but unsightly	wider plant spacing to improve air movement, balanced fertility curative fung. tmts. are cleared for P.M.	Resistant varieties, Benlate Rubigan, Bayleton, Triforine
Crepe Myrtle	foliar application	5 acres; 115,500 plants	none, but unsightly	wider plant spacing to improve air movement, balanced fertility, curative fung. tmts. are cleared for P.M.	Resistant varieties, Benlate, Zyban/Duosan, Bayleton, Triforine
Crepe Myrtle	aerial application	30 acres; 693,000 plants	unsightly, but not damaging	wider plant spacing to improve air movement, balanced fertility, curative fung. tmts.	Resistant varieties, Rubigan Zyban/Duosan, Bayleton, Triforine
Crepe Myrtle	aerial application	1 acre; 23,100 plants	none	wider plant spacing to improve air movement, balanced fertility, curative fung. tmts.	Resistant varieties, Benlate, Rubigan, Zyban/Duosan, Triforine
Crepe Myrtle	aerial application	2 acres; 46,200 plants	none	wider plant spacing to improve air movement, balanced fertility curative fung. tmts.	Resistant varieties, Benlate Rubigan, Zyban/Duosan, Bayleton
Wisteria	foliar application	0.25 acres	none, but unsightly	balanced fertility, wide plant spacing, good sanitation, curative fung. tmts.	none

Table 5b. SHRUBS, WARM TEMPERATE (continued)

Crop/Site	Application	Area Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternative Chemical Control/Problems
Photinia spp. & cultivars	Ground application as a foliar spray (hand gun sprayer) 21 oz/100 gal water	100%	80-90%	Proper irrigation timing, proper fertilization program, rouging, sanitation & Daconil 2785 75%WP; 12.9 oz/100 gal water Daconil 2787 F	Triadimefon, mancozeb, triforine. Best control is alternating chlorothalonil w/ triforine weekly fungicide applications
Photinia spp. & cultivars	Ground application as a foliar spray 1 oz/50 gal water or 2 oz/100 gal water	100%	80-90%	Proper irrigation timing, fertilization program, rouging, sanitation & weekly fungicide applications	Mancozeb, triforine. Best proper control is alternating chlorothalonil w/ triforine.
Photinia spp. & cultivars	Ground application as a foliar spray		8-10%		Chlorothalonil, bayleton, mancozeb
Photinia spp.	Foliar sprays 80% WP		100%	Irrigation timing, foliar sprays, pruning	Chlorothalonil, Triadimefon, triforine
Photinia spp. & cultivars	Rubigan 12.5% EC	35%	12-15%	Avoid late afternoon irrigations	Chlorothalonil, triforine
Photinia spp. & cultivars	Ground application as a foliar spray 1 lb/100 gal water, 0.5 lb/100 gal water	100%	20-25%	Pruning, prophylactic sprays in early spring, adequate winter protection	None

Table 6a. SHRUBS, COOL TEMPERATE

Crop/Site	Area in Cultivation	Disease/Organism	% Area Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Azalea, Rhododendron Mountain Laurel Western US	Not available	Cercospora leaf spot, petal blights, leaf spots and blights, Phytophthora dieback	10-15%	Zn + Maneb, Dithane M45 or F45, Manzate 200	Varies	Varies
Azalea, Rhododendron Western US	Not available	Botrytis blight, leaf spots, Rhizoctonia	10-15%	Chipco 26019, 50%	Varies	Varies
Azalea, Rhododendron Western US	Not available	Botrytis and Sclerotinia blight	10-15%	Vinclozolin 50 WP (Ronalin)	Varies	Varies
Azalea, Rhododendron, Mountain Laurel Western US	Not available	Powdery mildew, Ovulinia petal blight	10-15%	Bayleton 25 WP	Varies	Varies
Azalea, Rhododendron Western US	Not available	Damping off, Pythium, Phytophthora root rots, petal blights	10-15%	Ethazole	As needed	Varies
Azalea, Rhododendron Western US	Not available	Damping off, stem rots Pythium & Phytophthora	10-15%	Banrot 15:25 WP, 8G	As needed	Varies
Boxwood (Buxus spp.)	6.2 million plants	Botrytis canker macrophoma dieback Volutella blight	8-10%	Benlate DF50 and Dithane M45, Manzate 200 or Fore	3-5	Weekly during high disease pressure or first signs of disease

Table 6a. SHRUBS, COOL TEMPERATE (continued)

Crop/Site	Plants or Area in Cultivation	Disease/Organism	% Area Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Azalea, Rhododendron Eastern US	4822	Phytophthora blight Ovulinia petal blight	15%	Mancozeb (Manzate 200, Fore)	12/yr	3-14 da
Azalea Eastern US	4822	Rhizoctonia web blight	15%	Daconil 2787	4 to 8	7-14 da
Azalea Eastern US	4822	Rhizoctonia web blight Botrytis storage mold	15%	Chipco 26019	4 to 8	7-14 da
Azalea Eastern US	4822	Rhizoctonia web blight Ovulinia petal blight	15%	Benlate	3-4/yr drench 6-8/yr foliar	Soil drench at planting, then drench monthly; foliar spray at 14 days
Azalea, Rhododendron Mountain Laurel Eastern US	4822	Phytophthora root rot	20%	metalalxyl (Subdue) 2EC	3/yr	2 month
Azalea, Rhododendron Mountain Laurel Eastern US	4822	Phytophthora root rot Pythium root rot	20%	etridiazole (Truban)	6	monthly
Azalea, Rhododendron Mountain Laurel Eastern US	4822	Phytophthora root rot Pythium root rot	20%	Fosetyl-Al (Aliette)	6	monthly
Azalea, Rhododendron Mountain Laurel Eastern US	4822	Pythium root rot Phytophthora root rot Rhizoctonia root rot	15%	Banrot	2-6/yr	1-3 mo
Azalea, Rhododendron Eastern US	4822	Ovulinia petal blight	50%	Bayleton	1	Apply as flower buds show color

Table 6a. SHRUBS, COOL TEMPERATE (continued)

Crop/Site	Plants or areas in Cultivation	Disease/Organism	% Areas Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Azalea Western US	Not available	Cercospora leaf spot, Botrytis blight, Phytophthora dieback, Powdery mildew	10-15%	Champion WP (77%) or F (37.5%) (cupric hydroxide)	As needed	Varies
Azalea Western US	Not available	Botrytis blight	10-15%	Termil (Exotherm) 20%	As needed	Varies
Azalea Western US	Not available	Botrytis bight, Cercospora leaf spot, Phytophthora dieback, Powdery mildew	10-15%	Kocide 101 or 606F (cupric hydroxide)	As needed	Varies
Azalea Western US	Not available	Damping off	10-15%	ICI Folpet 50WP	As needed	Varies
Azalea Western US	Not available	Ovulinia petal blight stem rots	10-15%	Terraclor 75W, Turficide 24EC	As needed	Varies
Azalea Western US	Not available	Ovulinia petal blight	10-15%	Ziram F-4, W-76	As needed	Varies
Azalea Western US	Not available	Powdery mildew	10-15%	Triforine 18.2% EC Funginex 6.5% EC	As needed	Varies
Rhododendron Western US	Not available	Rust	10-15%	Plantvax 75W	As needed	Varies

Table 6a. SHRUBS, COOL TEMPERATE (continued)

Crop/Site	Plants or area in Cultivation	Disease/Organism	% area Infected	Chemical/ Formulation	Number of Applications	Timing (days)
Azalea, Rhododendron, Mountain Laurel Western US	Not available	Bud twig bight, dieback	10-15%	Bordeaux mixture (Pratt)	As needed	Varies
Azalea, Rhododendron Western US	Not available	Flower & leaf blights	10-15%	Duosan/Zyban 15:60 WP	As needed	Varies
Azalea, Rhododendron Western US	Not available	Anthracnose, flower & leaf gall, leaf blights & spots scorch	10-15%	CP-Basic Copper	As needed	Varies
Azalea, Rhododendron Mountain Laurel Western US	Not available	Ovulinia petal blight, Phytophthora dieback, cocospora	10-15%	Daconil 2787 (75 WP, 40 F)	As needed	Varies
Azalea, Rhododendron Western US	Not available	Pythium or Phytophthora root rots	10-15%	Aliette 80 WP	As needed	Varies
Azalea, Rhododendron Western US	Not available	Pythium & Phytophthora root rots	10-15%	Subdue 2E or 5G	As needed	Varies
Azalea Western US	Not available	Damping off, Pythium & Phytophthora root rots	10-15%	Banol 66.5% EC	As needed	Varies

Table 6b. SHRUBS, COOL TEMPERATE

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Azalea, Rhododendron, Mountain Laurel Western US	Foliar 1.2-2.4 lb a.i./100 gal	Unk	25%	Spray when disease occurs	CP-basic copper, CuOH Chipco 26019, Duosan/Zyban, Daconil 2787, Terraclor, Bayleton, Ziram
Azalea, Rhododendron Western US	Drench or foliar spray 16-32 oz/100 gal	Unk	<10%	Spray or drench when disease appears	Cupric hydroxide, Exotherm, Kocide 101 or 606, Ornalin 50 WP, Manzate 200, Duosan Zyban, Daconil 2787
Azalea, Rhododendron Western US	Foliar sprayer	Unk	<10%	Spray when disease occurs	Chipco 26019 50 WP, Cupric hydroxide, Exotherm, CuOH, Manzate 200, Duosan/Zyban, Daconil 2787
Azalea, Rhododendron Mountain Laurel Western US	Foliar spray	Unk	<10%	Spray when disease occurs	Ziram, Terraclor, Daconil 2787 Triforine/funginex, Fore, Dithane M45, Manzate 200
Azalea, Rhododendron Western US	Drench 10 oz/100 gal	Unk	<10%	Drench as preventative treatment or after symptoms appear	Banrot, Subdue, Aliette
Azalea, Rhododendron Western US	Foliar spray	Unk	<10%	Spray as protectant or when disease appear	Folpet, Banol, Truban or Terrazole, Subdue, Aliette
Buxus	Ground application as foliar spray 0.25 lb + 0.75 lb/ 100 gal water	0-20%	5-7%	Proper irrigation & medium/soil drainage & fungicide sprays applied as described above	Sound horticultural practices

Table 6b. SHRUBS, COOL TEMPERATE (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Azalea, Rhododendron Eastern US	1.2 lb/100 gal foliar spray	220	10%	Ground cover for container area essential, limit nitrogen application reduce overhead irrigation, foliar fungicide sprays pruning	Captan, Benomyl, Triadimefon
Azalea Eastern US	1.3 lb/100 gal foliar spray	552	25%	Cultural including plant spacing & timing irrigation, coupled with fungicide spray	Benomyl, Iprodione
Azalea Eastern US	0.5-1.0 lb/100 gal foliar spray	400	25%	Cultural, including plant spacing & timing irrigation, coupled with fungicide spray	Benomyl, Chlorothalonil
Azalea Eastern US	0.5 lb/100 gal	702	20%	Cultural, including plant spacing, irrigation & pruning	Iprodione, chlorothalonil, mancozeb, triadimefon,
Azalea, Rhododendron Mountain Laurel Eastern US	0.25-1.0 oz/100 gal per 400-800 sq ft soil drench	2099	30%	Soilless media, soil drenches at planting then bi-monthly, sanitation, resistant varieties	Aliette, Truban
Azalea, Rhododendron Mountain Laurel Eastern US	1.0-3.3 oz/100 gal/ 400 sq. ft soil drench (80%)	310	30%	Soilless media, soil drenches at planting then bi-monthly, sanitation, resistant varieties	Subdue, Aliette
Azalea, Rhododendron Mountain Laurel Eastern US	4 lb/100 gal/acre soil drench (20%) foliar spray (80%)	1082	30%	Soilless media, sanitation including gravel for container media	Truban, Subdue
Azalea, Rhododendron Mountain Laurel Eastern US	2.4-4.8 oz/100 gal/ 400 sq. ft. soil drench (100%)	432	20%	Used in propagation as soil drench, soilless media, sanitation	Aliette, Truban, Subdue
Azalea, Rhododendron Eastern US	0.2-2 oz/100 gal	960	70%	Make one application as flower buds show color	Benomyl, mancozeb

Table 6b. SHRUBS, COOL TEMPERATE (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Azalea Western US	Varies	Unknown	Unknown	Apply to foliage as protective spray before disease symptoms appear	CP-Basic Copper, Termil, Kocide 101 or 606F, Chipco 26019, Ornalin 50WP, Manzate 200, Dithane M45 or F45, Duosan/Zyban, Daconil 2787, Bayleton, Triforine/Funginex
Azalea Western US	Varies	Unknown	Unknown	Apply at regular intervals as a preventative treatment	Champion Wp or F, Kocide 101 or 606F, Chipco 26019, Ornalin 50WP
Azalea Western US	1 lb/100 gal	Unknown	Unknown	Apply as protective spray before disease symptoms appear; repeat	Champion WP77 or F37.5, Exotherm Termil 20, Chipco 26019, Ornalin 50WP, Manzate 200, Dithane M45 or F45, Daconil 2787, Subdue 3E, Triforine/Funginex, Bayleton 25WP
Azalea Western US	1-2 lb/100 gal	Unknown	Unknown	Apply as preventative drench	Truban/Terrazole 25EC, 5G; Banrot 15/25WP, 8G; Banol EC
Azalea Western US	12 oz/100 gal	Unknown	Unknown	Drench when disease symptoms appear	Banrot, Chipco 26019
Azalea Western US	2 tsp/gal	Unknown	Unknown	Apply as spray to flowers when disease	Manzate 200, Dithane M45 or F45, Daconil 2787, Terraclor 75W or Turfcide 24EC, Bayleton 25WP
Azalea Western US	Varies	Unknown	Unknown	Spray when disease symptoms appear	Bayleton 25WP, Champion WP or F, Kocide 101 or 606F
Rhododendron Western US	1.6-2.4 oz/100gal	Unknown	Unknown	Spray foliage when disease symptoms appear	None (local label in Oregon and Washington)

Table 6b. SHRUBS, COOL TEMPERATE (continued)

Crop/Site	Application	Acres Treated	Yield Loss w/o Fungicides	Control Management Practices	Alternatives to Chemical Control/Problems
Azalea, Rhododendron Mountain Laurel Western US	Unknown	Unknown		Spray as protectant or when diseases occur	Duosan/Zyban, CP-Basic Copper, Daconil, Manzate 200, Chipco 26019, Copro 50
Azalea, Rhododendron Western US	Unknown	Unknown		Spray when disease symptoms appear	CP-Basic Copper, copper hydroxide, Chipco 26019, Ornalin, Manzate 200, Dithane M45, Daconil, Terraclor, Bayleton, Ziram
Azalea, Rhododendron Western US	Varies	Unknown		Spray when disease symptoms appear	Duosan/Zyban, Chipco 26019, Manzate 200
Azalea, Rhododendron Western US	2 pt/100 gal	Unknown		Spray when disease symptoms appear	Captan WP, Kocide 101 or 606 Chipco 26019, Manzate 200, Dithane M45, Duosan/Zyban, Daconil 2787, Terraclor, Bayleton, Ziram, Subdue
Azalea, Rhododendron Western US	0.5-1.5 pt/sq. ft. drench	Unknown		Applied as spray or drench as preventative or when disease symptoms appear	Subdue 2E, 5G; Truban, Banrot
Azalea, Rhododendron Western US	1-4 oz/100 gal	Unknown		Applied as preventa-tive drench or when symptoms appear	Aliette, Banrot, Ethazole (Truban, Terrazole)
Azalea Western US	Varies	Unknown		Apply as protective drench treatment	Banrot, Truban/Terrazole, Subdue, Aliette, Folpet